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Efficiency of Liquid-Overcoated Blazed Gratings

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Beamline(s): X24C

Introduction: For near-normal incidence operation at EUV wavelengths, blazed gratings must have low blaze angles (1-4 degrees), and fabrication of accurate and smooth groove profiles has proven to be difficult. However, the firm of Carl Zeiss in Germany has developed a new technique to overcome this problem. Ion-etched gratings of relatively high blaze angle (~8 degrees) are coated with a liquid polymer, which is then cured. The resulting grating has a reduced blaze angle and reduced roughness.

Methods and Materials: Three flat blazed gratings with 3600 grooves/mm were procured from Zeiss. The target blaze angles were 2.7, 4.1, and 2.0 degrees for near-normal incidence operation at wavelengths of 131 (2nd inside order), 131 (3rd inside order), and 98 (2nd inside order) Angstroms, respectively. The measured blaze angles were determined from atomic force microscope measurements at Zeiss, and the grating efficiencies were measured as a function of wavelength using the X24C reflectometer.

Results: AFM measurements at 5 different locations on each grating produced average blaze angles in agreement with the target values and with standard deviations of 20%. For the 2.7-degree grating, fig. 1 shows the measured efficiency for 6 different orders as a function of wavelength at near-normal incidence. The values are comparable to those obtained from other bare fused-silica gratings. The derived groove efficiency is shown in Fig. 2. At short wavelengths the highest values are in the second order as designed, and the values set new records. Similar results were obtained for the other two gratings.

Conclusions: The results show great promise. To obtain high efficiency the gratings will be coated with matched multilayers, and the efficiency and AFM measurements will be repeated for full validation of the technique. Measured efficiencies approaching 30% are expected after multilayer coating.

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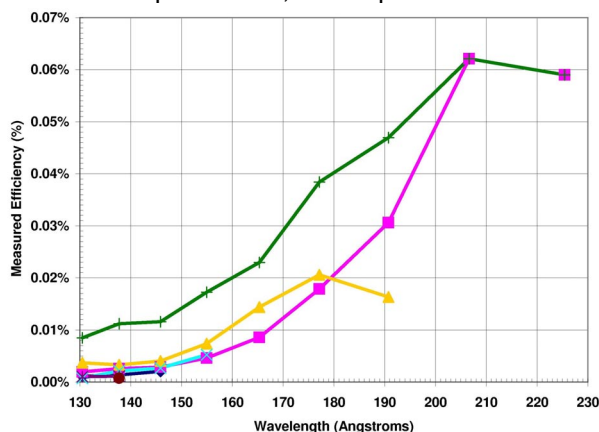


Fig. 1-Measured Efficiency of a Liquid-Overcoated Blazed Grating with an average blaze angle of 2.7 degrees. Each curve is for a different order, and the sum of all observed orders is also shown.

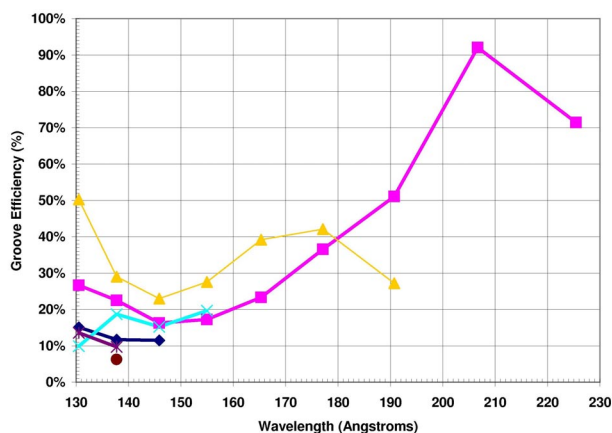


Fig. 2-Derived Groove Efficiency of a Liquid-Overcoated Blazed Grating with an average blaze angle of 2.7 degrees. Each curve is for a different order.